Directed Self Assembly

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Introduction

Current Challenges to manufacturing

- Limits of 193i and multiple patterning are approaching
- 10nm resolution has been demonstrated with multiple patterning
- EUV as an alternative is expensive with low throughput

Advantages of Directed Self Assembly

- Resolution of 20nm and possibly lower
- Can be integrated with current patterning techniques
- Inexpensive

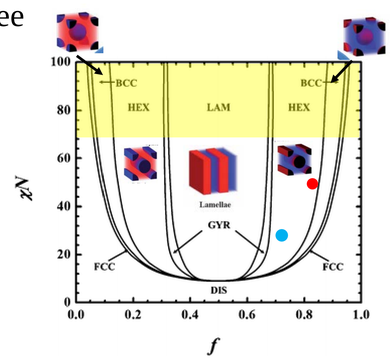
Disadvantages of DSA

- Complex patterns can be difficult or impossible to form
- Has to be integrated into an existing lithography process
- Pattern formation may take large amounts of time

Polymer Structure

Phase Diagram

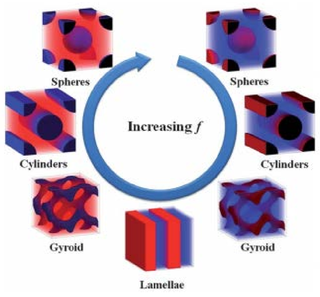
- Structure is determined by three factors
- N is the degree of polymerization
- x is the Flory interaction parameter
- f is the volume fraction
- The polymers used were large enough to be in the highlighted region and above
- Reference research is shown by the dots PS-b-PDMS (blue) and PS-b-PEO (red)



Phase Diagram

Polymers Used

- Polystyrene(PS)-b-Polydimethylsiloxane(PDMS)
  - MW of 67k-22k
  - Cylindrical (HEX) structure
- PS-b-Polyethyleneoxide(PEO)
  - MW of 52.5k-35.6k
  - Cylindrical structure
  - 29% mole
- PS-PEO at 40% mole
  - Lamellae structure

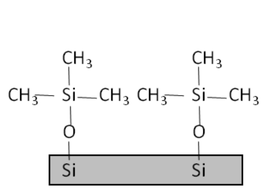


Polymer Structures

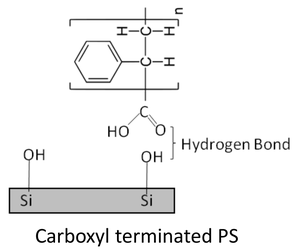
Process

Surfaces

- Two coating surfaces: HMDS treated and PS under-layer
  - Carboxyl terminated PS used as under-layer
  - Coated at 3000rpm from toluene



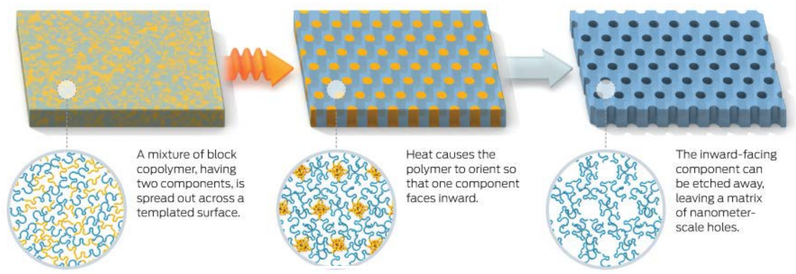
HMDS Treated



Carboxyl terminated PS

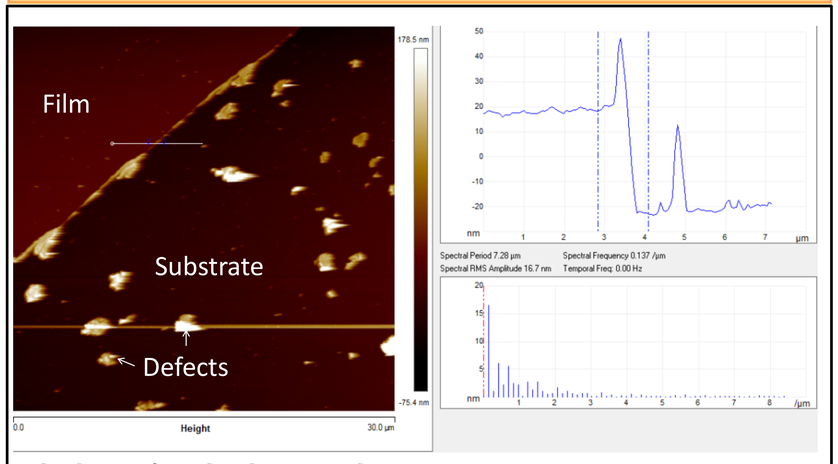
Process flow

- Coated at 3000 rpm for 2 minutes
- Annealing conditions
  - PS-PDMS annealed at 170°C for 24 hours
  - PS-PEO annealed in chloroform vapor for 3 hour



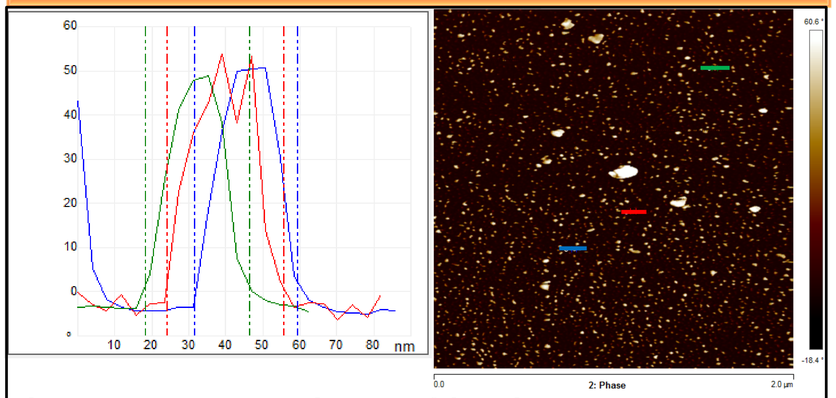
Via Hole Process

Thickness Results



- Thickness found to be around 40nm
  - Expected value for a single layer
- Defects are from making the step from an X-acto knife

Phase Results



Phase imaging measures elasticity of the polymer
There was a large enough contrast with the 29% mole sample to create the image
Via hole structures were found to be 30nm across

Results Summary

Polymer	HMDS treated	PS under-layer
PS-b-PDMS	De-wetted	Non-uniform film
PS-b-PEO 29%mole	No structure formed	Via holes
PS-b-PEO 40%mole	Crystallized	Crystallized

Conclusion

Conclusion

- De-wetting was the main source of error
- Too high of a PEO ratio will result in crystallization
- 30nm via holes can be achieved with the 29%mole PEO on PS under-layer
- DSA is very sensitive to the surface

Future Work

- Use a lower weight, smaller polymer
- Have a more rigorous cleaning procedure for samples before processing
- Use different brush polymers
- Take AFM images before annealing to see the effects of annealing on separation of the blocks

Acknowledgements

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